NASA Procedural Requirements

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COMPLIANCE IS MANDATORY

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Appendix D. Systems Engineering Management Plan

D.1 Purpose and Use

The purpose of this appendix is to provide an annotated outline for a SEMP for use by NASA programs and projects in planning the technical effort whether it is required for in-house or contracted projects. The SEMP outline provides guidance for the format and content of a project SEMP. The SEMP is the technical planning document for systems engineering. The SEMP is designed to be an integrated technical planning document for the conduct and management of the required technical effort. The resulting technical plan represents the agreed-to and approved tailoring of the requirements of the SE NPR to satisfy project technical requirements. The plan is used by the technical team responsible for generating technical work products to integrate and manage the full spectrum of technical activities required to engineer the system covered by the SEMP. The SEMP should be coordinated with the project plan for integration of the technical planning and modifications related to the allocated resources including cost, schedule, personnel, facilities, and deliverables required. The SEMP also will be used to evaluate the team's technical approach, to make technical risk assessments, and to measure progress.

D.2 Terms Used

Terminology is a key factor in ensuring a common understanding of the technical effort to be accomplished. Terms used in the SEMP should have the same meaning as the terms used in the SE NPR.

D.3 SEMP Preparation

D.3.1 Outline Use

The SEMP outline in this appendix is guidance to be used in preparing a project SEMP. For a small project, the material in the SEMP can be placed in the project plan's technical summary and this annotated outline be used as a topic guide. D.3.2 Tailoring and Customization

Program and project tailoring and customization need to be consistent with Paragraph 2.2 of this NPR. The SEMP is to include documentation of any tailored requirements. Significant customization of SE processes should also be documented in the SEMP.

D.3.3 Surveillance-Type Projects

For projects with significant portions of the engineering work contracted out, the SEMP should scope and plan the NASA project's implementation of the common technical processes before, during, and at the completion of the contracted effort. This should include planning the technical team's involvement in RFP preparation, in source selection activities, and in acceptance of deliverables. The interface activities with the contractor, including NASA technical team involvement with and monitoring of contracted work, should be a focus of the SEMP.

D.4 SEMP Annotated Outline

D.4.1 SEMP Title Page

Systems Engineering Management Plan

(Provide a title for the candidate program/project and designate

a short title or proposed acronym in parenthesis, if appropriate.)

_____ _____
Designated Governing Authority/Technical Authority Date

_____ _____
Program/Project Manager Date

_____ _____
Chief Engineer Date

_____ _____
Date

_____ _____
Date

By signing this document, signatories are certifying that the content herein is acceptable as direction for engineering and technical management of this program/project and that they will ensure its implementation by those over whom they have authority.

Figure D-1 - Systems Engineering Management Plan Title Page

D.4.2 General Structure

The SEMP contains the following sections, unless they have been tailored out. Cross references to detailed information in related technical plans are included in each pertinent SEMP section.

a. Purpose and Scope.

b. Applicable Documents.

c. Technical Summary.

d. Technical Effort Integration.

e. Common Technical Processes Implementation.

f. Technology Insertion.

g. Additional SE Functions and Activities.

h. Integration with the Project Plan and Technical Resource Allocation.

i. Compliance Matrix (Appendix H.2 of SE NPR).

j. Appendices.

D.4.3 Purpose and Scope

This section provides a brief description of the purpose, scope, and content of the SEMP. The scope encompasses

the SE technical effort required to generate the work products necessary to meet the exit criteria for the product life-cycle phases.

D.4.4 Applicable Documents

This section lists the documents applicable to SEMP implementation and describes major standards and procedures that the technical effort needs to follow.

D.4.5 Technical Summary

This section contains an executive summary describing the problem to be solved by this technical effort.

D.4.5.1 System Description

This subsection contains a definition of the purpose of the system being developed and a brief description of the purpose of the products of the product layer of the system structure for which this SEMP applies. Each product layer includes the system end products and their subsystems and the supporting or enabling products and any other work products (plans, baselines) required for the development of the system. The description should include any interfacing systems and system products, including humans, with which the system products will interact physically, functionally, or electronically.

D.4.5.2 System Structure

This subsection contains an explanation of how the technical portion of the product layer (including enabling products, technical cost, and technical schedule) will be developed and integrated into the project piece of the work breakdown structure and how the overall system structure will be developed. This subsection contains a description of the relationship of the specification tree and the drawing tree with the products of the system structure and how the relationship and interfaces of the system end products and their life-cycle-enabling products will be managed throughout the planned technical effort.

D.4.5.3 Product Integration

This subsection contains an explanation of how the product will be integrated and will describe clear organizational responsibilities and interdependencies whether the organizations are geographically dispersed or managed across Centers. Project integration includes the integration of analytical products.

D.4.5.4 Planning Context

This subsection contains the programmatic constraints (e.g., NPR 7120.5) that affect the planning and implementation of the common technical processes to be applied in performing the technical effort. The constraints provide a linkage of the technical effort with the applicable product life-cycle phases covered by the SEMP including, as applicable, milestone decision gates, major life-cycle and technical reviews, key intermediate events leading to project completion, life-cycle phase, event entry and exit criteria, and major baseline and other work products to be delivered to the sponsor or customer of the technical effort.

D.4.5.5 Boundary of Technical Effort

This subsection contains a description of the boundary of the general problem to be solved by the technical effort, including technical and project constraints (governing NPR's use of heritage hardware, predefined interfaces, cost, schedule, and technologies) that affect the planning. Specifically, it identifies what can be controlled by the technical team (inside the boundary) and what influences the technical effort and is influenced by the technical effort but not controlled by the technical team (outside the boundary). Specific attention should be given to physical, functional, and electronic interfaces across the boundary.

D.4.5.6 Cross-References

This subsection contains cross-references to appropriate nontechnical plans that interface with the technical effort and contains a summary description of how the technical activities covered in other plans are accomplished as fully integrated parts of the technical effort.

D.4.6 Technical Effort Integration

This section contains a description of how the various inputs to the technical effort will be integrated into a coordinated effort that meets cost, schedule, and performance objectives.

D.4.6.1 Responsibility and Authority

This subsection contains a description of the organizing structure for the technical teams assigned to this technical effort and includes how the teams will be staffed and managed, including: (a) who will serve as the DGA for this project and, therefore, will have final approval for this SEMP; (b) how multidisciplinary teamwork will be achieved; (c) identification and definition of roles, responsibilities, and authorities required to perform the activities of each planned common technical process; (d) planned technical staffing by discipline and expertise level with human resource

loading; (e) required technical staff training; and (f) assignment of roles, responsibilities, and authorities to appropriate project stakeholders or technical teams to ensure planned activities are accomplished.

D.4.6.2 Contractor Integration

This subsection contains a description of how the technical effort of in-house and external contractors is to be integrated with the NASA technical team efforts. This includes establishing technical agreements, monitoring contractor progress against the agreement, handling technical work or product requirements change requests, and acceptance of deliverables. The section will specifically address how interfaces between the NASA technical team and the contractor will be implemented for each of the 17 common technical processes. For example, it addresses how the NASA technical team will be involved with reviewing or controlling contractor-generated design solution definition documentation or how the technical team will be involved with product verification and product validation activities.

D.4.6.3 Analytical Tools That Support Integration

This subsection contains a description of the methods (such as integrated computer-aided tool sets, integrated work product databases, and technical management information systems) that will be used to support technical effort integration.

D.4.7 Common Technical Processes Implementation

Each of the 17 common technical processes will have a separate subsection that contains the plan for performing the required process activities as appropriately tailored. (See Paragraph 2.2 for the process activities required for tailoring.) Implementation of the 17 common technical processes includes: (1) generating outcomes needed to satisfy the entry and exit criteria of the applicable product life-cycle phase or phases identified in D.4.5.4; and (2) producing the necessary inputs for other technical processes. These sections contain a description of the approach, methods, and tools for:

a. Identifying and obtaining adequate human and nonhuman resources for performing the planned process, developing the work products, and providing the services of the process.

b. Assigning responsibility and authority for performing the planned process, developing the work products, and providing the services of the process.

c. Training the technical staff performing or supporting the process, where training is identified as needed.

d. Designating and placing designated work products of the process under appropriate levels of configuration management.

e. Identifying and involving stakeholders of the process throughout each phase of the life cycle.

f. Monitoring and controlling the process.

g. Objectively evaluating adherence of the process and the work products and services of the process to the applicable requirements, objectives, and standards and addressing noncompliance.

h. Reviewing activities, status, and results of the process with appropriate levels of management and resolving issues.

D.4.8 Technology Insertion

This section contains a description of the approach and methods for identifying key technologies and their associated risks and criteria for assessing and inserting technologies, including those for inserting critical technologies from technology development projects.

D.4.9 Additional SE Functions and Activities

This section contains a description of other areas not specifically included in previous sections but that are essential for proper planning and conduct of the overall technical effort.

D.4.9.1 System Safety

This subsection contains a description of the approach and methods for conducting safety analysis and assessing the hazards to operators, the system, the environment, and the public.

D.4.9.2 Engineering Methods and Tools

This subsection contains a description of the methods and tools not included in D.4.7 that are needed to support the overall technical effort and identifies those tools to be acquired and tool training requirements.

D.4.9.3 Specialty Engineering

This subsection contains a description of engineering discipline and specialty requirements that apply across

projects and the product layer of the system structure. Examples of these requirement areas include planning for health and safety, reliability, human systems integration, logistics, maintainability, quality, operability, and supportability.

D.4.9.4 Technical Performance Measures

This subsection contains a description of the TPMs that have been derived from the MOEs and MOPs for the project. The set should include the required TPMs as stated in Paragraph 6.2.7 of this NPR, the appropriate set of highly recommended Common Leading Indicators as described in NPR 7120.5 Formulation Agreement and Program/Project Management Plan templates, and any other project-unique TPM selected for this project. The format and methodology of how the parameters will be reported (graph, table, plan versus actual, etc.) should be described. The reporting period and reporting recipients should also be stated.

D.4.9.5 Heritage

This section contains a description of the heritage or legacy products that will be used in the project. Discussions should include a list of the products and their use, the rationale for using them, if any delta certifications for the planned environments will be conducted, and any analysis performed to ensure their compatibility.

D.4.9.6 Other

This section is reserved for other SE functions and activities as needed.

D.4.10 Integration with the Project Plan and Technical Resource Allocation

This section contains how the technical effort will integrate with project management and defines roles and responsibilities. This section addresses how technical requirements will be integrated with the project plan to determinate the allocation of resources, including cost, schedule, and personnel, and how changes to the allocations will be coordinated.

D.4.11 Compliance Matrix

This section will include the completed compliance matrix per the template in Appendix H.2 of this NPR, including tailoring justifications.

D.4.12 Appendices

Appendices are included, as necessary, to provide a glossary, acronyms and abbreviations, and information published separately for convenience in document maintenance. Included would be: (a) information that may be pertinent to multiple topic areas (e.g., description of methods or procedures); (b) charts and proprietary data applicable to the technical efforts required in the SEMP; and (c) a summary of technical plans associated with the project. Each appendix should be referenced in one of the sections of the engineering plan where data would normally have been provided.

| TOC | ChangeHistory | Preface | Chapter1 | Chapter2 | Chapter3 | Chapter4 | Chapter5 | Chapter6 | AppendixA | AppendixB | AppendixC | AppendixD | AppendixE | AppendixF | AppendixG | AppendixH | AppendixI | AppendixJ | ALL |

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